

10/574096

IAP20 Rec'd PCT/PTO 31 MAR 2006
SPECIFICATION

DRESSING METHOD IN VERTICAL DUPLEX-HEAD SURFACE
GRINDING MACHINE

TECHNICAL FIELD

The present invention relates to a dressing method in a vertical duplex-head surface grinding machine comprising a pair of upper and lower grinding wheels rotatable on a vertical axis, and to a dressing method adapted, for example, to grind upper and lower surfaces of a disc portion of a work integrally having the disc portion and a hub portion.

BACKGROUND ART

For dressing grinding stones of a vertical duplex-head surface grinding machine, a dressing device 110 incorporated in the surface grinding machine as shown in Fig. 8 has been utilized. A dressing wheel 101 mounted on the dressing device 110 is arranged to implement dressing of the grinding stones 105.

Referring to Fig. 8, the dressing device 110 will be briefly explained. The dressing device 110 comprises a swing arm 100 pivotally mounted on the grinding machine and the dressing wheel 101 supported in a manner to be driven for rotation at the distal end of the swing arm 100, with the other end of the swing arm 100 being connected to a rod 103 of a driving cylinder 102. The dressing wheel 101 may be rotated by an oil motor or a transmission motor by way of an appropriate transmission mechanism (not

shown).

For dressing the upper and lower grinding stones 105 in the dressing device 110, the swing arm 100 is pivoted so as to insert the dressing wheel 101 between the upper and lower grinding stones 105, the grinding stones 105 are started to rotate simultaneously with the rotation (self-rotation) of the dressing wheel 101, and the grinding stones 105 are moved up and down, whereby end surfaces (grinding surfaces) of the grinding stones 105 are dressed.

A method concerning dressing of grinding stones of a duplex-head surface grinding machine is revealed in Japanese Unexamined Patent Publication No. 09-070757.

DISCLOSURE OF INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

In order to produce a work having a finish of high quality using a vertical duplex-head surface grinding machine, upper and lower grinding stones are required to have parallel and flat grinding surfaces and also the work is required to be held in parallel by a work holding jig. Particularly in grinding a work having a thin disc portion like a brake disc and the like, as deflection and the like of the work has influence over the finish, levels of parallelism of the above grinding surfaces and the work become an extremely important factor with respect to grinding quality of the work.

Dressing is implemented to maintain parallelism and flatness of the grinding surfaces, however, in case of a dressing method employing a structure of supporting the dressing wheel 101 by the swing arm 100 in a

cantilever style as shown in Fig. 8, it becomes difficult to hold the dressing wheel 101 in a normal position during the use for an extended time due to a limit inherent in the rigidity of the swing arm 100, thereby causing a situation requiring longer time in operations to adjust the parallelism.

Also, as the dressing device 110 comprising the swing arm 100, a cylinder 102, or the like is built in the surface grinding machine, the overall dimension of the surface grinding machine is enlarged and the costs is also increased.

MEANS FOR SOLVING THE PROBLEMS

The first invention with an object to solve the above problems is a dressing method in a vertical duplex-head surface grinding machine including a pair of upper and lower grinding stones rotatable on a vertical axis and a work holding part capable to hold a work at a set location and rotatable on its vertical axis, the work held by the work holding part being inserted between the grinding stones to grind upper and lower surfaces simultaneously, the dressing method is characterized in that the work holding part comprises first and second reference planes for alignment of the work, the first reference plane being a circumferential surface coaxial with a self-rotating axis of the work holding part and the second reference plane being a surface normal to the self-rotating axis, a dressing tool having a dressing wheel is provided with a fitting portion to fit in the first reference plane and an abutment surface to abut against the second reference plane, the dressing tool being mounted in alignment on the work holding part through fitting the fitting portion in the first reference plane and abutting

the abutment surface against the second reference plane, and the upper and the lower grinding stones are dressed through inserting the dressing tool supported on the work holding part between the grinding stones.

Also, the present invention is characterized in that in the above first invention the work holding part comprises a self-rotating shaft rotatable on its vertical axis and a work holding jig capable to be attached and detached to the self-rotating shaft and hold the work in a set location, the self-rotating shaft comprises the first and the second reference planes, the work holding jig for alignment with respect to the self-rotating shaft comprises a shaft fitting portion to fit in the first reference plane and a shaft abutment surface to abut against the second reference plane, and the dressing tool is configured to be mounted to the self-rotating shaft in place of the work holding jig through fitting the fitting portion of the dressing tool in the first reference plane of the self-rotating shaft and abutting the abutment surface of the dressing tool against the second reference plane of the self-rotating shaft.

Furthermore, the present invention is characterized in that in the above first invention the work comprises integrally a disc portion and a hub portion, the work holding jig comprises an inner circumferential surface for center alignment constituting the first reference plane and fitting with the outer circumferential surface of the hub portion of the work and a work reference surface constituting the second reference plane and against which the lower surface of the disc portion abuts, the dressing tool comprises a cylindrical member constituting the fitting portion and having a same diameter with that of the hub portion of the work, the lower surface of the

flange portion of the cylindrical member constituting the abutment surface, and a disc shaped dressing wheel coaxially connected to the cylindrical member, and the dressing tool is configured to be mounted to the work holding jig in place of the work through fitting the cylindrical member in the inner circumferential surface for center alignment of the work holding jig and the lower surface of the flange portion of the cylindrical member is abutted against the work reference surface.

The second invention is a dressing method in a vertical duplex-head surface grinding machine comprising a pair of upper and lower grinding stones rotatable on a vertical axis, a work holding jig capable to hold a work having integrally a disc portion and a hub portion in a set location and rotatable on its vertical axis, and a clamping device to press the work against the work holding jig, the work holding jig having an inner circumferential surface for center alignment to fit with an outer circumferential surface of the hub portion of the work and a work reference surface against which a lower surface of the disc portion abuts, and the work held by the work holding jig being inserted between the grinding stones to grind upper and lower surfaces simultaneously is characterized in that a dressing tool comprises a cylindrical member having an external diameter same with that of the hub portion of the above work and a disc shaped dressing wheel connected coaxially to the cylindrical member, the cylindrical member of the dressing tool is fitted in the inner circumferential surface for center alignment of the work holding jig and a lower surface of a flange portion of the cylindrical member is abutted against the work reference surface, the dressing tool is pressed against the work holding jig

by the clamping device, and the dressing tool supported on the work holding jig is inserted between the grinding stones.

Also, the present invention employs in the above second invention the work holding jig comprising a cylindrical positioning piece having integrally the inner circumferential surface for center alignment and the work reference surface.

Furthermore, the present invention is in the above second invention an upper end of the cylindrical portion of the dressing tool is pressed by a steel ball of the clamping device.

EFFECTS OF THE INVENTION

(1) As dressing operations for the grinding stones are performed by the dressing tool mounted on the work holding part (self-rotating shaft or work holding jig) through operations similar to those in work grinding, no dressing device provided with a swing arm, a cylinder for driving, and the like of the prior art will be needed and operations which might have been required in handling the dressing device itself as in the prior art can be eliminated, thereby attaining reduction in the number of parts, production costs, and overall dimension of surface grinding machines as well as easier dressing operations.

(2) As dressing is performed by the dressing tool mounted on the work holding part with the fitting portion of the dressing tool being fitted in the first reference plane of the work holding part to align the work and the abutment surface of the dressing tool being abutted against the second reference plane, parallelism of the dressing wheel relative to the grinding

stones can be maintained easily and accurately resulting in an improvement in dressing accuracy.

(3) As the dressing tool is configured to be mounted to the self-rotating shaft utilizing the first and the second reference planes onto which the work holding jig is mounted with precise alignment by means of the first and the second reference planes, the dressing tool can be mounted with precise alignment as well and the parallelism of the dressing wheel relative to the grinding stones can be maintained easily and accurately resulting in an improvement in dressing accuracy.

(4) As dressing is performed by the dressing tool fixed to the work holding jig with the cylindrical member of the dressing tool being directly fitted in the inner circumferential surface for center alignment of the work holding jig and a lower surface of the flange portion of the cylindrical member being abutted against the work reference surface, similarly to the above, parallelism of the dressing wheel relative to the grinding stones can be maintained easily and accurately resulting in an improvement in dressing accuracy.

(5) The employment of the cylindrical positioning piece comprising integrally the inner circumferential surface for center alignment and the work reference surface enables to simplify the structure of the work holding jig and also secure the dressing tool into the set position simply and easily.

(6) The method to press the upper part of the cylindrical portion of the dressing tool by the steel ball in the clamping device enables to save space required for clamping.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a side of view of a vertical duplex-head surface grinding machine capable of implementing the method in accordance with the present invention.

Fig. 2 is a vertical sectional view of a work holding jig and a work in a mounting position.

Fig. 3 is a vertical sectional view of a work holding jig, a work, and a press unit in a grinding position.

Fig. 4 is an exploded vertical sectional view of a dressing tool to be employed in the method in accordance with the present invention.

Fig. 5 is a bottom view of a cylindrical member.

Fig. 6 is a vertical sectional view of the dressing tool mounted on a work holding part.

Fig. 7 is a vertical sectional view of a dressing tool mounted on the work holding part in accordance with a second embodiment.

Fig. 8 is a plan view of the prior art.

BEST MODE FOR CARRYING OUT THE INVENTION

[First embodiment]

[Structure of the vertical duplex-head surface grinding machine]

Figs. 1 through 3 show a vertical duplex-head surface grinding machine capable of implementing the dressing method in accordance with the present invention. The structure of the vertical duplex-head surface grinding machine will be explained first. Referring to Fig. 1 showing a side view, a pair of upper and lower grinding wheels 2, 3 opposing vertically each

other are housed in a body case 1, the grinding wheels 2, 3 being fixedly mounted on grindstone shafts 4, 5 disposed coaxially on a vertical axis O3 respectively. Both grindstone shafts 4, 5 are disposed in a manner moveable by a lifting mechanism in a vertical direction and operatively connected to a power transmission mechanism for rotation in opposite directions each other.

An index table 6 for work supply is fixed to the upper end of a vertical table drive shaft 7, the table drive shaft 7 being rotatably supported on a cylindrical support case 8 by way of a bearing on a table rotation axis O1 and operatively connected to a drive motor by way of a transmission mechanism (not shown).

A pair of work holding jigs 10 are installed on the index table 6 and also a clamping device 12 to secure a work W on each of the work holding jigs 10 from the above is equipped above the index table 6.

The work holding jigs 10 are positioned with a phase difference of 180 degrees on the table rotation axis O1 and supported on cylindrical jig support cases 15 so as to be driven for rotation on respective self-rotating axes O2. Through a half turn of the index table 6, each of the work holding jigs is shiftable between a grinding position A2 on a side of the grinding wheels and a mounting position A1 opposite the grinding position.

The clamping device 12 comprises a pair of cylinders 22 each having a clamp rod 21 extendable downward and a press unit 23 mounted at the lower end of each of the clamp rods 21. Each of the cylinders 22 is positioned coaxially with a corresponding self-rotating axis O2 of the respective work holding jig 10 and fixed to a corresponding bracket 24

secured to the upper surface of the index table 6, thereby capable to rotate together with the work holding jig 10 on the rotation axis O1 when the index table 6 is turned.

Fig. 2 is an enlarged vertical sectional view of a work holding jig 10 and a work W located in the mounting position A1. The work W is, for example, a brake disc for vehicles comprising a hub 26 with a flange portion 26a integral thereto and an annular disc 27 secured to the flange portion 26a, and both upper and lower surfaces of the disc 27 can be ground.

Within a jig support case 15 a self-rotating shaft 30 is rotatably supported by way of a bearing 29, and the work holding jig 10 is fixed to the upper surface of the self-rotating shaft 30 coaxially with the self-rotating axis O2, the lower end of the self-rotating shaft 30 being operatively connected to a drive motor by way of a gear transmission mechanism (not shown). The self-rotating shaft 30 and the work holding jig 10 constitute a work holding part 9.

The work holding jig 10 is formed into an annular shape and an annular positioning piece 28 is secured to its upper surface coaxially therewith. On the upper surface of the positioning piece 28 an annular work reference surface 32 against which a lower face of the flange portion 26a of the work W abuts is formed protruding upwardly, with an inner circumferential surface 31 of the positioning piece 28 being set to a size in which the hub 26 of the work W fits. Also, on the work holding jig 10 a lock pin 37 is installed protruding upwardly therefrom to prevent rotation of the work W relative to the work holding jig 10, the lock pin 37 being inserted movably in a vertical direction into a rod insert hole 40 formed in the work

holding jig 10 and biased upwardly by a spring 42. The lock pin 37 is configured to prevent rotation of the work W relative to the work holding jig 10 through engaging its upper end with a mounting bolt 45 or the flange portion 26a of the work W.

In this case, when the hub 26 of the work W is fitted in, the inner circumferential surface 31 of the positioning piece 28 constitutes a first reference plane for horizontal alignment of the work W and the work reference surface 32 of the positioning piece 28 constitutes a second reference plane for vertical alignment of the work W.

Fig. 3 is an enlarged vertical sectional view of the press unit 23 of the clamping device and the work holding jig 10 located in the grinding position A2. The press unit 23 comprises a steel ball 46 abuttable against the periphery of a center aperture of the work W from the above, a ball holding tube 47 fittingly supporting the steel ball 46 in a manner to protrude downwardly, a ball retainer 48 having a conic receiving surface 48a for abutting against the upper surface of the steel ball 46, a bearing holder 51 mounted to the lower end of the clamping rod 21 free to rotate on the self-rotating axis O2 by way of a bearing 50, and a lower cover 52 secured to the lower surface of the bearing holder 51. All of the steel ball 46, the ball holding tube 47, the ball retainer 48, and the bearing holder 51 are positioned on an axis coaxial with the self-rotating axis O2 of the work holding jig 10.

The inner circumferential surface of the lower half of the ball holding tube 47 is formed into a taper having a smaller diameter at the lower part, and the taper can hold the steel ball 46 in a manner to protrude

downwardly. The ball retainer 48 is fittingly inserted into the ball holding tube 47 from the top and connected to the lower cover 52 together with the ball holding tube 47 in a manner to protrude downwardly.

[Structure of the dressing tool]

Fig. 4 is an exploded vertical sectional view of a dressing tool utilized in the present invention, the dressing tool comprising a disc shaped dressing wheel 60, a cylindrical member 62 having a flange portion 62b integrally formed therewith, and an annular retaining disc 65. A plurality of bolt holes 66 are formed in the retaining disc 65 spaced apart circumferentially. The dressing wheel 60 has a mounting hole 61 at its center and a thick outer ring portion, with upper and lower end surfaces of the thick outer ring portion constituting grinding surfaces formed in parallel each other. The external diameter of the dressing wheel 60 is larger at least than that of the work. The flange portion 62b of the cylindrical member 62 is provided with an annular protrusion 62c integrally formed at its periphery and a center aperture 63, the center aperture 63 being provided with a conic ball receive surface 63a at its upper end. A lower surface 62d of the flange portion 62b which is utilized in maintaining a horizontal position of the dressing wheel 60 is formed into a surface precisely in normal to a dressing tool axis O4. The circumferential surface 62a of the cylindrical member 62 is cylindrical surface which is utilized for center alignment has an external diameter D1, the external diameter D1 being set to be the same with that of the hub 26 of the work shown in Fig. 2 and being a size capable to fit in the inner circumferential surface 31 for center alignment.

Fig. 5 is a bottom view of the cylindrical member 62. In the flange portion 62b thereof a pair of stopper holes 68 is formed and a plurality of threaded bores 69 are disposed in a circumferentially spaced relationship each other.

[Method for assembling the dressing tool]

Referring to Fig. 4, the dressing wheel 60 is fitted with the periphery of the flange portion 62b of the cylindrical member 62 and also abutted against the upper surface of the annular protrusion 62c and then the retaining disc 65 is mounted on the dressing wheel 60. Through threadedly engaging a plurality of bolts 71 inserted through the bolt holes 66 with the threaded bores 69 in the flange portion 62b, the dressing wheel 60, the cylindrical member 62, and the retaining disc 65 are combined into an integral body.

[Method for grinding the work]

Referring to Fig. 1, in the mounting position A1 the press unit 23 is elevated, the work W is mounted on the work holding jib 10, and then the clamping rod 21 is lowered to press the press unit 23 against the center of the upper surface of the work W.

Referring to Fig. 2, when the work W is mounted, the hub 26 of the work W is fitted in the inner circumferential surface 31 of the positioning piece 28, the lower surface of the flange portion 26a abuts against the annular work receiving reference surface 32 of the positioning piece 28, and the lock pin 37 is located in a position circumferentially deviated from the mounting bolt 45. When the press unit 23 is lowered under this condition, the steel ball 46 is pressed against an upper peripheral edge P of the inner

circumferential surface (center aperture) of the hub 26 to fix the work W in alignment with a set position as shown in Fig. 3.

As the area being pressed by the steel ball 46 is contained within the work reference surface 32, the work can be subjected to a stable, accurate positioning in a clamping operation.

Upon completion of the clamping operation in the mounting position A1 as seen in Fig. 1 the work is moved to the grinding position A2 through making the index table 6 a half turn.

Referring to Fig. 3, during the movement of the work the grinding wheels 2, 3 are retracted upward and downward, respectively. Upon completion of the movement, the work holding jig 10 is started to self-rotate in order to turn the work W on the self-rotating axis O2, and then the space between the upper and the lower rotatable grinding wheels 2, 3 is decreased to grind both the upper and the lower end surfaces simultaneously.

As the lock pin 37 is preventing the work W from turning relative to the work holding jig 10 frictional force will be able to effect no turn over the work W.

When the grinding of the work W is complete, the upper and the lower grinding wheels 2, 3 retract from the upper and the lower end surfaces of the work W upward and downward, respectively, and the self-rotation of the work holding jig 17 is stopped. Then, as the index table 6 makes a half turn, the work holding jig is moved to the mounting position A1 as seen in Fig. 1 and the press unit 23 is lifted.

[Dressing method]

As shown in Fig. 6, the dressing tool after assembly is mounted on

the work holding jig 10 in place of the work and secured in alignment in a similar manner as explained with respect to the grinding case, and then the grinding surfaces of the upper and the lower grinding stones 2, 3 are dressed in an operation similar to that for grinding.

Putting it in another way, for mounting the dressing tool as seen in Fig. 6, the cylindrical member 62 is fitted in the inner circumferential surface 31 of the positioning piece 28 and the lower surface 62d of the flange portion 62d is brought into abutment against the upper reference plane 32 (work reference surface) 32 of the positioning piece 28. When the steel ball 46 of the press unit 23 is pressed against the upper conic surface 63a, the dressing tool is fixed to a set position similar to that of the work. As a result, the positioning of the upper and the lower grinding surfaces of the dressing wheel 60 can be maintained in precisely normal to the self-rotating axis O2. Also, as the lock pin 37 engages the stopper holes 68 of the cylindrical member 62, the dressing tool is prevented from rotating relative to the work holding jig 10.

After securing the dressing tool, the work holding jig 10 is moved to the grinding position A2 as seen in Fig. 1. When the dressing tool is started to rotate (self-rotation) the grinding stones 2, 3 are also started to rotate, then through narrowing the vertical space between the grinding stones 2, 3, dressing of the grinding stones 2, 3 can be implemented.

As explained hereinabove, the first embodiment includes constituent members that follow. Namely, the work holding jig 10 of the work holding part 9 is provided with the work reference surface (second reference plane) 32 constituting the upper surface of the positioning piece 28 and the inner

circumferential surface (first reference plane) 31 of the positioning piece 28. The dressing tool is provided with the cylindrical member (fitting part) 62 capable to fit in the inner circumferential surface 31 of the positioning piece 28 and the lower surface 62d (abutment surface) of the flange portion 62b to abut against the work reference surface 32 of the positioning piece 28.

The dressing tool is mounted to the work holding jig 10 from which the work W has been removed in the aligned position through fitting the cylindrical member 62 of the dressing tool in the inner circumferential surface of the positioning piece 28 and the lower surface 62d of the flange portion 62b is abutted against the work reference plane 32 of the positioning piece 28.

The dressing tool is secured to the work holding jig 10 utilizing the clamping device 12 to secure the work W to the work holding jig 10 is capable to perform dressing of the grinding stones in the method similar to that employed in grinding the work W.

[Second embodiment]

Fig. 7 is a vertical sectional view of a dressing tool mounted on the work holding part 9 in accordance with the second embodiment of the present invention. The first embodiment has been described that the dressing tool can be mounted to the work holding jig 10 comprising the work holding part 9 in place of the work W, however, in the present embodiment the dressing tool is designed to be mounted on the self-rotating shaft 30 in place of the work holding jig 10. Detailed explanation thereof will follow.

Between the self-rotating shaft 30 and the work holding jig 10 in accordance with the second embodiment and the first embodiment an

alignment structure is disposed to position the work holding jig 10 resultantly indirectly the work W with respect to the self-rotating shaft 30.

[Details of the alignment structure]

As shown in Fig. 7, the alignment structure comprises a circular recess 73 formed on the upper surface of the self-rotating shaft 30 with its center on the self-rotating axis O2 and an alignment ring 74 fitted in the recess 73. The alignment ring 74 having an annular shape is disposed coaxially with the self-rotating axis O2 and secured to the self-rotating shaft 30 by a bolt 79 and the like. As the alignment ring 74 is formed with a thickness larger than the depth of the recess 73, some portion of the upper part of the alignment ring 74 projects upwardly from the recess 73.

The upper surface 30a of the self-rotating shaft about the alignment ring 74 is formed into a horizontal flat surface normal to the circumferential surface of the alignment ring 74. Also, on the upper surface of the self-rotating shaft 30 a plurality of threaded bores 30b are formed spaced apart for an equal angle about a circle having its center on the self-rotating axis O2.

As shown in Fig. 3, the alignment structure comprises on the lower surface of the work holding jig 10 a circular recess 75 formed with its center on the self-rotating axis O2. The inner diameter of the recess 75 is formed into a size capable to fit with the outer circumference of the ring 74 and the recess 75 constitutes a shaft fitting portion capable to fit with the upper part of the alignment ring 74. Furthermore, the lower surface 76 of the work holding jig 10 located about the recess 75 constitutes a shaft abutting surface abutting against the upper surface 30a of the self-rotating shaft 30.

The above alignment structure properly position the work holding jig 10 relative to the self-rotating shaft 30 through fitting the recess (the shaft fitting portion) 75 with the outer circumference of the alignment ring 74 and abutting the lower surface (shaft abutting surface) 76 of the work holding jig 10 against the upper surface 30a of the self-rotating shaft 30. As a result, the work W held by the work holding jig 10 can be aligned, although in an indirect manner.

The outer circumferential surface 74a of the alignment ring 74 constitutes the first reference plane in order to position the work holding jig 10 in a horizontal direction (the direction perpendicular to the self-rotating axis O2) relative to the self-rotating shaft 30 resultantly indirectly a horizontal direction of the work W, and the upper surface 30a of the self-rotating shaft 30 constitutes the second reference plane in order to position them in a vertical direction (the direction of self-rotating axis O2).

As shown in Fig. 6, on the circumferential part of the work holding jig 10 a plurality of bolt holes 77 with a number and at locations corresponding to the threaded bores 30b are formed vertically therethrough, with work holding jig 10 being fixed to the self-rotating shaft 30 by threadedly engaging bolts 78 inserted through the bolt holes 77 with the threaded bores 30b of the self-rotating shaft 30.

[Structure and assembling method of the dressing tool]

As shown in Fig. 7, similarly to the first embodiment the dressing tool comprises a disc shaped dressing wheel 60, a cylindrical member (mounting member) 62 having the flange portion 62b integrally formed therewith, and an annular retaining disc 65. However, the configuration of

the cylindrical member 62 is different from that of the first embodiment.

The cylindrical member 62 of the second embodiment comprises a cylindrical portion 62e located on the lower side and the flange portion 62b located on the upper side, the upper part of the cylindrical portion 62e being closed by the flange portion 62b. Proximate to the lower end of the inner circumferential surface of the cylindrical portion 62e a recess 80 is formed with its center on the dressing tool axis O4. The recess 80 has an inner diameter capable to fit with the outer circumferential surface 74a of the above alignment ring 74, constituting a fitting portion capable to fit with the alignment ring 74.

The lower surface 62f about the recess 80 of the cylindrical portion 62e constitutes an abutment surface to abut against the upper surface 30a (second reference plane) of the self-rotating shaft. The abutment surface 62f is used for maintaining the horizontal position of the dressing wheel 60 and formed into a surface exactly normal to the dressing tool axis O4.

In the cylindrical member 62 bolt holes 81 vertically passing from the flange portion 62b to the cylindrical portion 62e are formed, the cylindrical member 62 being fixed to the self-rotating shaft 30 through threadedly engaging the bolts 78 inserted through the bolt holes 81 with threaded bores 30b formed on the self-rotating shaft 30. For the bolts 78, bolts to secure the work holding jig 10 to the self-rotating shaft 30 are appropriated. In other words, the dressing tool can be secured utilizing the fitting mechanism for the work holding jig 10.

On the upper surface of the flange portion 62b a circular protrusion 62g extending upward is formed, the protrusion 62g being fitted in a center

aperture for positioning (aligning) the cylindrical member 62 and the retaining disc 65.

The method for assembling the dressing tool is similar to that for the first embodiment. The mounting hole 61 at the center of the dressing wheel 60 is fitted with the outer periphery of the flange portion 62b, the circumference of the mounting hole is abutted against the upper surface of the annular protrusion 62c, and the retaining disc 65 is mounted on the dressing wheel 60. Through threadedly engaging a plurality of the bolts 71 inserted through the bolt holes 66 with the threaded bores 69 in the flange portion 62b, the dressing wheel 60, the cylindrical member 62, and the retaining disc 65 are combined into an integral body.

The retaining disc 65 has through holes 82 formed at locations corresponding to the bolt holes 81. The dressing tool in an assembled condition can be fastened to the self-rotating shaft 30 by threading the bolts 78 into the bolt holes 81 by way of the through holes 82 from the side of the retaining disc 65.

[Dressing method]

Under the second embodiment, the assembled dressing tool is fixed to the self-rotating shaft 30 in place of the work holding jig 10 and then the both grinding stones 2, 3 is dressed through an operation similar to that for grinding. In this case, the dressing tool is secured to the set position as in the case for the work holding jig 10 and the upper and the lower grinding surfaces of the dressing wheel 60 are aligned at exactly right angles to the self-rotating axis O2.

As explained hereinabove, the second embodiment includes

constituent members that follow. Namely, for alignment of the work holding jib 10 resultantly the work, the self-rotating shaft 30 of the work holding part 9 is provided with the outer circumferential surface (first reference plane) 74a of the alignment ring 74 and the upper surface (second reference plane) 30a of the self-rotating shaft 30. The dressing tool is provided with the recess (fitting portion) 80 for fitting with the outer circumferential surface of the alignment ring 74 and the lower surface (abutment surface) 62f of the cylindrical member 62 for abutting against the upper surface 30a of the self-rotating shaft 30.

Then, the dressing tool can be mounted in alignment on the self-rotating shaft 30 from which the work holding jig 10 has been removed through fitting the recess 80 of the cylindrical member 62 of the dressing tool with the outer circumferential surface of the alignment ring 74 and then abutting the lower surface 72f of the cylindrical member 62 against the upper surface 30a of the self-rotating shaft 30.

The dressing tool can be secured utilizing the bolts 78 which are for securing the work holding jig 10 to the self-rotating shaft 30 and then dressing of the grinding stones is implemented in a similar method employed in grinding the work W.

[Another embodiment]

The present invention is not limited to the above embodiments and modifications of design are possible as desired. For example, in place of the alignment ring 74 explained in the above second embodiment a disc shaped member may be fitted in the recess 73, or omitting the alignment ring 74 a protrusion bulging in a circular shape may be formed at the center of the

upper surface of the self-rotating shaft 30 in order to utilize the outer circumferential surface of the protrusion as the first reference plane.

INDUSTRIAL APPLICABILITY

The present invention can be utilized effectively in dressing a pair of upper and lower grinding wheels of a vertical duplex-head surface grinding machine.